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EFFECTS OF INITIAL RAT CAPTURES ON SUBSEQUENT CAPTURE SUCCESS OF TRAPS

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ABSTRACT: Trapping records from studies conducted in Hawaiian sugarcane fields were analyzed to determine the effects of rat captures on subsequent capture success of *Rattus norvegicus*, *R. rattus*, and *R. exulans*. Traps that captured rats were subsequently more likely to capture another rat of the same species. We detected no differences in trap responses of males and females, nor did we observe any evidence that capture success of Polynesian rats and roof rats was affected by previous captures of Norway rats. This increased trap success may have been due to residual trap odors, or to greater success of traps set in optimal locations. Researchers should exercise caution in interpreting trapping results, and take precautions to eliminate residual trap odors due to previous captures. A better understanding of the effects of congeneric odors on the trapability of rats could lead to the development of more attractive and selective bait formulations, improved trapping techniques, and better interpretation of research results.

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INTRODUCTION

Traps have been employed for centuries to control rodent pests (Snetsinger 1983:247-251). They also are indispensable for studying the biology, impact, and control of these animals. Researchers use traps to capture animals for laboratory experiments, study movements, home ranges, and social interactions, and evaluate the efficacy and safety of control techniques. Thus, vertebrate pest specialists and researchers should try to control factors that potentially influence capture success or bias research results.

Residual trap odors potentially affect rodent capture success. Rodents use olfaction for mediating social interactions, perceiving their surroundings, and avoiding danger. Studies have shown that residual trap odors influence the trapability of voles (Boonstra et al. 1982), deer mice (Mazdzer et al. 1976; Daly et al. 1978, 1980; Wuensch 1982; Drickamer 1984), kangaroo rats (Daly et al. 1978, 1980), pocket mice (Daly et al. 1978, 1980), house mice (Rowe 1970, Drickamer et al. 1992, Wuensch 1982), ground squirrels (Harris and Murie 1982, Salmon and Marsh 1989), jumping mice (Stoddart and Smith 1986), cotton rats (Summerline and Wolfe 1973), and rats (Gao 1991, Mallick 1992).

Personnel at the USDA's Denver Wildlife Research Center Hawaii Field Station routinely use traps to capture rats for laboratory and field studies involving depredations in Hawaiian agricultural crops. Many traps capture more than one rat during a trapping session. However, the effect of rat captures on subsequent captures in the same traps is not known. A better understanding of the effects of congeneric odors on the trapability of rats could lead to the development of more attractive and selective bait formulations, improved trapping techniques, and better interpretation of research results.

METHODS

The data for this paper were collected during previous studies of rats in sugarcane fields on the islands of Hawaii and Kauai. All fields were surrounded by gulches or other waste areas with noncrop vegetation, and contained sugarcane >12 mo of age and of various varieties.

Trapping in each field was conducted over a four-day period. A compass, machete, and Hip-Chain® distance-measuring device were used to establish a transect in the interior of each field starting at a noncrop edge or interior road and extending 160 m into the field. Fifty traps (Haguruma® live cage traps or McGill® snap traps, depending on the study) were placed at 3-m intervals along each transect (reference to commercial products is for identification only and does not imply endorsement by the U.S. Department of Agriculture). At each trapsite, an area approximately 30 x 30 cm to one side of the transect was cleared of sugarcane stalks and leaves, and a trap was placed directly on the ground and secured with a numbered wire flag. Grated coconut was scattered along traplines three days before the traps were baited with chunks of coconut and set. The traps were checked between sunrise and 1200 h on each of the four days after traps were set. Traps were rebaited and reset as necessary. Animals captured in the live traps were weighed, identified to species and sex, and released at the capture site. Animals captured in the snap traps were individually labeled with field and trap number and transported to the Denver Wildlife Research Center Hawaii Field Station for identification.

To determine the effect of rat captures on subsequent capture success, we conducted chi-square analyses on 2x2 contingency tables to compare rat capture success during nights 2 to 4 for traps that captured a rat of a given species on the first night, versus capture success during nights 2 to 4 for traps that did not capture a rat on the first night. We used a 2x3 contingency table (males, females, and no captures) to examine whether the gender of captures on the first night influenced the sex of subsequent captures of the same species in the same trap. Traps that captured mongooses (*Herpestes auropunctatus*) and house mice (*Mus musculus*) were excluded from the analyses.

RESULTS

Study 1, Snap Traps

We captured 526 Norway rats during 11,200 trap-nights. The percentage of the traps that caught a Norway rat on the first night that also caught a Norway rat on a following night was 14.7, compared to only 8.6% of traps that had no captures on the first night but caught a Norway rat on a following night (χ^2 = 9.87, 1 df, $\underline{P}$ = 0.002) (Table 1). The sex of Norway rats captured in a trap did not influence the sex of subsequent Norway rat captures (χ^2 = 2.22, 2 df, $\underline{P}$ = 0.33) .

We captured 324 Polynesian rats during the study. The percentage of the traps that captured a Polynesian rat on the first night and subsequently captured another Polynesian rat was 16.7, compared to 6.7% for the traps that caught nothing on the first night (χ^2 = 18.85, 1 df, $\underline{P}$ < 0.001) (Table 1). Here, too, the sex of Polynesian rat captures during nights 2 to 4 was not influenced by the sex of Polynesian rat captures on night 1, (χ^2 = 0.21, 2 df, $\underline{P}$ = 0.90).

One-hundred and thirty-five roof rats were captured. Traps that captured a roof rat during the first night were more likely to capture another roof rat during subsequent nights (19.3%) than were traps that caught nothing on the first night (2.6%) (χ^2 = 51.67, 1 df, $\underline{P}$ < 0.001) (Table 1). There was no evidence that males and females responded differently to traps based on the gender of previous captures (χ^2 = 0.82, 2 df, $\underline{P}$ = 0.66).

Captures of Polynesian rats and roof rats were not affected by previous captures of Norway rats (χ^2 = 0.02, 1 df, $\underline{P}$ = 0.89).

Study 2, Live Traps

Three-hundred and twenty-three Norway rats, 27 Polynesian rats, and 5 roof rats were captured in live traps during 3,600 trap-nights. Thirty-six percent of traps that had a Norway rat capture on night 1 also captured a Norway rat during nights 2 to 4, whereas only 19.7% of traps that caught nothing on the first night subsequently caught a Norway rat (χ^2 = 15.00, 1 df, $\underline{P}$ < 0.001) (Table 2). No sex differences were noted in the capture success of male and female Norway rats based on the sex of previous captures (χ^2 = 0.91, 2 df, $\underline{P}$ = 0.64). Because of the low number of captures for Polynesian and roof rats, we did not analyze the data for these species. None of the traps that captured a Norway rat during the first night subsequently captured either a Polynesian rat or a roof rat.

Study 3, Snap Traps

Three-hundred and twenty-four Norway rats, 71 Polynesian rats, and 3 roof rats were captured during 3,600 trap-nights. Slightly more than 20% of traps that captured a Norway rat during the first night subsequently captured another Norway rat, compared to a success rate of 15.5% for traps that captured nothing during the first night (χ^2 = 2.21, 1 df, $\underline{P}$ = 0.14) (Table 3). Male and female Norway rats responded similarly to traps regardless of the gender of previously captured Norway rats (χ^2 = 0.74, 2 df, $\underline{P}$ = 0.69). The percentage of traps (Table 3) that captured a Polynesian rat during the first night and subsequently captured another Polynesian rat was 29.2%, compared to 4.9% for traps that captured nothing during the first night and subsequently captured a Polynesian rat (χ^2 = 24.3, 1 df, $\underline{P}$ < 0.001). There were not enough captures to analyze the trap responses of roof rats, or gender differences in trap responses of Polynesian rats. Five of 139 traps (3.6%) that captured a Norway rat during the first night subsequently captured either a Polynesian rat or a roof rat, versus 29 of 586 traps (4.9%) that had not captured a Norway rat on night 1 (χ^2 = 0.46, 1 df, $\underline{P}$ = 0.50)

Study 4, Live Traps

Livetrapping over 5,400 trap-nights yielded 333 Norway rats, 119 Polynesian rats, and 20 roof rats. Of the traps that caught Norway rats during the first night, 17.3% subsequently captured another Norway rat, compared to 17.3% for traps that had no captures on the first night (χ^2 = 0, 1 df, $\underline{P}$ = 0.98) (Table 4). No differences were noted between the sex of captures on nights 2 to 4 based on the gender of the first night's capture (χ^2 = 0.12, 2 df, $\underline{P}$ = 0.94). Just over 36% of the traps that caught a Polynesian rat subsequently captured another rat of this species, compared to only 4.7% of traps that did not capture a Polynesian rat on the first night (χ^2 = 67.41, 1 df, $\underline{P}$ < 0.001). We saw no evidence that male and female Polynesian rats reacted differently to traps based on the gender of previously captured Polynesian rats (χ^2 = 2.71, 2 df, $\underline{P}$ = 0.26). Nor did Polynesian rats and roof rats responded differently to traps that had captured Norway rats on night 1 versus traps that had not captured Norway rats (χ^2 = 1.18, 1 df, $\underline{P}$ = 0.28).

Study 5, Snap Traps

Three-hundred and sixty-six Norway rats, 239 Polynesian rats, and 9 roof rats were captured during 3,600 trap-nights. About 28% of traps that captured a Norway rat on the first night subsequently captured another Norway rat, versus 20% of traps that did not capture anything on the first night but captured a Norway rat during nights 2 to 4 (χ^2 = 3.67, 1 df, $\underline{P}$ = 0.055) (Table 5). The sex of Norway rat captures on night 1 had no apparent effect on subsequent capture success for either sex (χ^2 = 3.12, 2 df, $\underline{P}$ = 0.21). Twenty-nine percent of 68 traps that captured a Polynesian rat during the first night subsequently captured another Polynesian rat, versus 18.6% of traps that captured nothing on the first night (χ^2 = 4.31, 1 df, $\underline{P}$ = 0.04). There was a possible minor indication that both sexes of Polynesian rats were captured more often in traps that had previously captured females (χ^2 = 4.76, 1 df, $\underline{P}$ = 2, 0.09). Polynesian rats and roof rats did not respond differently to traps on the basis of whether they had captured Norway rats during the first night (χ^2 = 0.06, 1 df, $\underline{P}$ = 0.81).

DISCUSSION

Three of the five data sets for Norway rats, four of the five data sets for Polynesian rats, and the lone data set for roof rats indicate that capture success of rats was related to previous captures in the same traps and

Table 1. Number of snap traps with rat captures in 56 fields at four sugarcane plantations in Hawaii. Study 1, February to May 1989.

Day 1	Days 2-4			
Species	*R. norvegicus*	*R. exulans*	*R. rattus*	No captures
R. norvegicus	38	13	5	221
R. exulans	10	23	4	115
R. rattus	5	4	11	46
no captures	174	132	49	1840

Table 2. Number of live traps with rat captures in 18 fields at the Mauna Kea Agribusiness Co., Inc. sugarcane plantation near Hilo, Hawaii. Study 2, June to July 1991.

Day 1	Days 2-4			
Species	*R. norvegicus*	*R. exulans*	*R. rattus*	No captures
R. norvegicus	40	0	0	71
R. exulans	2	0	0	5
R. rattus	2	0	0	1
no captures	140	20	2	571

Table 3. Number of snap traps with rat captures in 18 fields at the Mauna Kea Agribusiness Co., Inc. sugarcane plantation near Hilo, Hawaii. Study 3, August 1991.

Day 1	Days 2-4			
Species	*R. norvegicus*	*R. exulans*	*R. rattus*	No captures
R. norvegicus	34	5	0	134
R. exulans	4	7	0	17
R. rattus	0	0	0	3
no captures	102	29	0	557

Table 4. Number of live traps with rat captures in 27 fields at the Mauna Kea Agribusiness Co., Inc. sugarcane plantation near Hilo, Hawaii. Study 4, November 1992.

Day 1	Days 2-4			
Species	*R. norvegicus*	*R. exulans*	*R. rattus*	No captures
R. norvegicus	24	4	0	13
R. exulans	10	16	2	28
R. rattus	4	1	1	3
no captures	143	34	8	682

Table 5. Number of snap traps with rat captures in 18 field sections at the Mauna Kea Agribusiness Co., Inc. sugarcane plantation near Hilo, Hawaii. Study 5, December 1992.

Day 1	Days 2-4			
Species	*R. norvegicus*	*R. exulans*	*R. rattus*	No captures
R. norvegicus	44	25	0	112
R. exulans	20	20	0	48
R. rattus	1	3	0	2
no captures	101	88	3	384

locations. Traps that captured rats were more likely than traps that had not captured rats to subsequently capture another rat of the same species. A similar phenomenon has been observed with deer mice (*Peromyscus* spp.) (Mazdzer et al. 1976; Daly et al. 1978, 1980; Drickamer 1984), house mice (*Mus musculus*) (Rowe 1970), and wood mice (*Apodemus*) (Stoddart et al. 1986). Although several studies have indicated that male and female deer mice (Mazdzer et al. 1976, Drickamer 1984), house mice (Rowe 1970), and rats (Gao 1991) respond differently to residual trap odors, we observed no such effect in our study. Captures of Norway rats had no apparent effect on subsequent capture success of Polynesian rats and roof rats.

Olfaction is important in the social biology of rodents (Stoddart 1974), and it is reasonable to assume that rats detect and respond to residual odors in traps. Odors convey information about species and individual identification (Johnson 1973), dominance and aggressiveness (Harvey et al. 1989), and reproductive state (Vandenbergh 1983, White et al. 1991). Our results indicate that rats may have responded to residual odors of previous captures. However, an alternative explanation is that traps had multiple captures simply because they were placed in strategic locations where captures were more likely. Our study was not designed to differentiate between the two possibilities. Nonetheless, prudence dictates that researchers should exercise caution in interpreting trapping results, and take precautions to eliminate residual trap odors due to previous captures.

More study is needed to clarifying the effects of congeneric odors on the behavior and trapability of rats. The results could lead to more effective methods for controlling damage by these pests, as well as help researchers interpret the results of trapping studies. Pheromones might be used to improve the selectivity and success of eradication trapping programs (Mazdzer et al. 1976), enhance consumption of toxic baits (Mason et al. 1988, Gao 1991), and promote more effective use of rodent repellents (Sullivan et al. 1990, Coulston et al. 1993, Epple et al. 1993).

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